

## AP8803EV1 EVALUATION BOARD USER GUIDE

### DESCRIPTION

The AP8803EV1, Figure 1, is a double sided evaluation board for the AP8803 LED driver with internal switch. The evaluation board is preset to drive 680mA into a single LED, or multiple LEDs, the maximum number of which depends on their total forward voltage drop.

The operating voltage is nominally 30 volts, but it can be reduced to a minimum of 8 volts. The 68uH inductor used in the circuit is based on this nominal supply, which should be connected across the +Vin and Gnd pins. **Note: The evaluation board does not have reverse battery protection.** The nominal current, 680mA, is set with the 0R15 sense resistor, R1.

Terminal CTRL provides a connection point for DC or PWM dimming and shutdown.

**Warning: At 30V nominal operation with 680mA output, the LED will be hot and very bright**

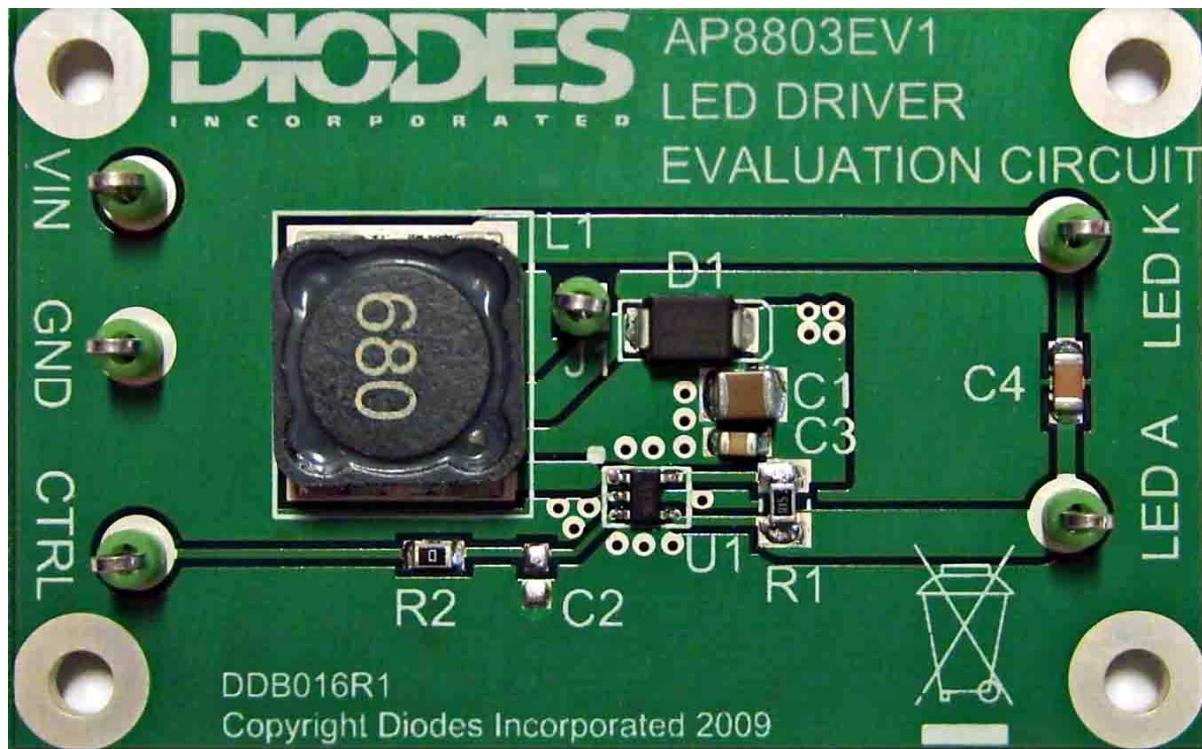


Figure 1: AP8803EV1 evaluation board

**AP8803 DEVICE DESCRIPTION**

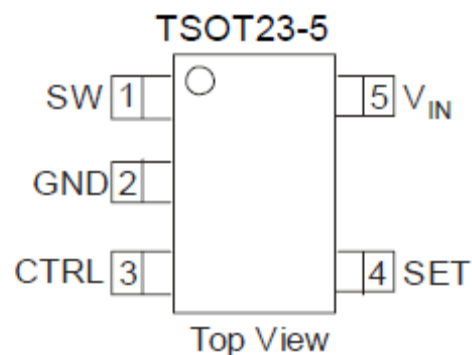
The AP8803 is a continuous mode inductive driver in a TSOT23-5 package, for driving one or more series-connected LEDs efficiently from a voltage source higher than the LED voltage. The device includes the output switch and a current sense circuit, which requires an external sense resistor to set the nominal current up to 1000mA.

**AP8803 DEVICE FEATURES**

- Drives one or more series-connected LEDs
- LEDs up to 1000mA.
- Internal 30V switch.
- Wide input voltage: 8V to 30V.
- Inherent open circuit LED protection.
- Brightness control using DC or PWM.
- Internal PWM filter.

**DEVICE APPLICATIONS**

- LED flashlights.
- High Power LED driving.
- Low-voltage halogen replacement LEDs.
- Automotive lighting.
- Illuminated signs.

**AP8803 Device Packages, Pin and Definitions**

TSOT23-5 pack

**AP8803 Device Pin Definition**

Name	Pin No	Description
SW	1	Drain of NDMOS switch.
GND	2	Ground (0V).
CTRL	3	Internal voltage ref. pin (1.25V) : <ul style="list-style-type: none"> <li>• Leave floating for normal operation.</li> <li>• Connect to GND to turn off output current.</li> <li>• Drive with DC voltage (0.3V to 1.25V) or with PWM signal to Adjust output current or....</li> <li>• Connect a capacitor from this pin to ground to set soft-start time.</li> </ul>
SET	4	Connect a sense resistor, $R_s$ , from the CTRL pin to $V_{IN}$ to sense the nominal output current. Nominal $I_{out} = 0.1 / R_1$
VIN	5	Input voltage: 8V to 30V. Decouple to ground with a 4.7uF or higher ceramic capacitor.

**ORDERING INFORMATION**

<b>EVALBOARD ORDER NUMBER</b>
AP8803EV1

<b>DEVICE ORDER NUMBER</b>
AP8803E5TA

**Please note: Evaluation boards are subject to availability and qualified sales leads.**

## AP8803EV1 EVALUATION BOARD REFERENCE DESIGN

The AP8803EV1 is configured to the reference design in Figure 2.

The operating voltage is a nominal 30V. The nominal current is set at 680mA with a 0R15 sense resistor, R1 and the circuit operates in continuous mode at approximately 180kHz, with a 68uH inductor and a single LED.

An accurate way of determining the current is to measure the voltage on the sense resistor. A 10K resistor and a 1uF capacitor can be used to form a low pass filter, the voltage across the capacitor representing a more stable DC reading of current. 100mV represents 1 Amp when using a 0R1 sense resistor.

The CTRL pin has a low pass filter within the AP8803 chip to provide some decoupling and a soft start, but the external capacitor C1 (100nF) is used to provide additional decoupling to reduce any high frequency noise, as well as providing an extra amount of soft start.

Both DC and PWM dimming can be achieved by driving the CTRL pin. For DC dimming, the CTRL pin may be driven between 0.3V and 1.25V. Driving the CTRL pin below 0.2V will shutdown the output current. For PWM dimming, an external open-collector NPN transistor or open-drain N-channel MOSFET can be used to drive the CTRL pin. The PWM frequency can be low, around 100Hz to 1kHz, or high, between 10kHz to 50kHz.

For low frequency PWM, C1 should be removed from the evaluation board, to give a more accurate duty cycle.

Shorting R2 will connect the test pin CTRL to device pin CTRL, if required.

The soft-start time will be nominally 0.5ms without capacitor C1. Adding C1 will increase the soft start time by approximately 0.5ms/nF

For other reference designs or further applications information, please refer to the AP8803 datasheet.

### Schematic Diagram

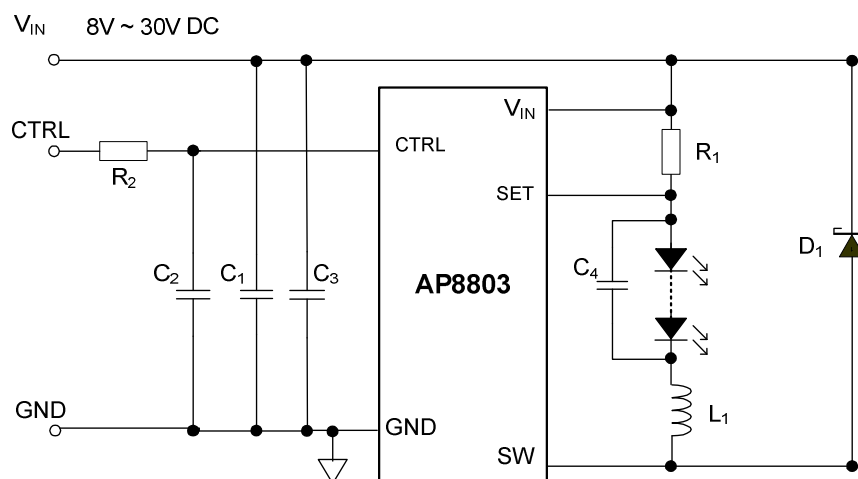


Figure 2: Schematic of the Evaluation Board

## AP8803 Operation

In normal operation, when voltage is applied at +Vin, the AP8803 internal NDMOS switch is turned on. Current starts to flow through sense resistor R1, inductor L1, and the LED. The current ramps up linearly, and the ramp rate is determined by the input voltage +Vin and the inductor L1. This rising current produces a voltage ramp across R1. The internal circuit of the AP8803 senses the voltage across R1 and applies a proportional voltage to the input of the internal comparator. When this voltage reaches an internally set upper threshold, the NDMOS switch is turned off. The inductor current continues to flow through R1, L1, the LED and the schottky diode D1, and back to the supply rail, but it decays, with the rate of decay determined by the forward voltage drop of the LEDs and the schottky diode. This decaying current produces a falling voltage at R1, which is sensed by the AP8803. A voltage proportional to the sense voltage across R1 is applied at the input of the internal comparator. When this voltage falls to the internally set lower threshold, the NDMOS switch is turned on again. This switch-on-and-off cycle continues to provide the average LED current set by the sense resistor R1. Please refer to the datasheets for the threshold limits, AP8803 internal circuits, electrical characteristics and parameters.

## AP8803EV1 Component list

Ref	Value	Package	Part Number	Manufacturer	Notes
U1	AP8803	TSOT23-5	AP8803E5TA	Diodes Zetex	DC-DC converter
D1	40V, 3A		B340B	Diodes Zetex	Schottky diode
R1	0R15	0805		Generic	5%
R2,	1K	0805		Generic	1%
C1	4.7uF 50V	1210	C1210X475K5RAC	Generic KEMET	X7R
C2, C3	100nF, 100V	0805	NMC0805X7R104K100 PF GRM21BR71H104KA01L	Generic NIC Comps MURATA	X7R
C4	100nF 100V	1206	NMC1206X7R104K100	Generic NIC Comps	X7R
L1	68uH		MSS1038-683ML NPIS24H680MTRF	Coilcraft NIC Comps	

Note: The component part numbers are correct at the time of publication. Diodes Inc reserves the right to substitute other parts where necessary, without further notification.

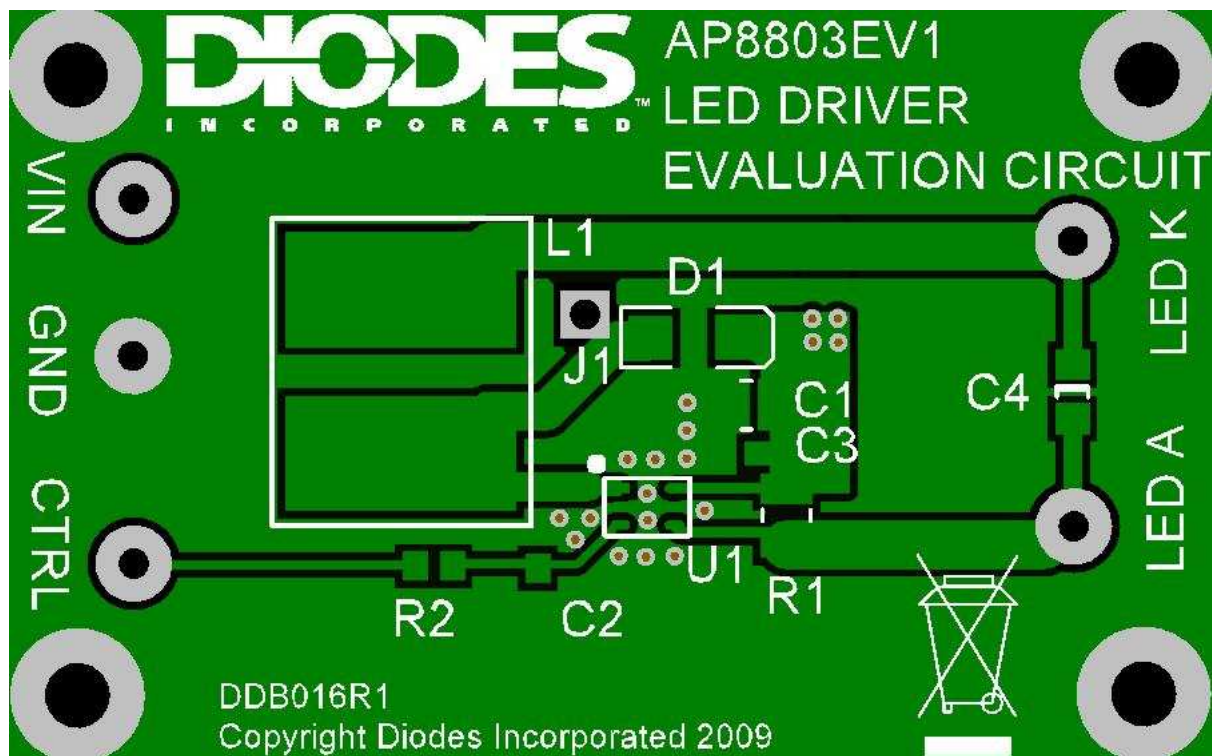


Figure 3: Component layout

AP8803EV1 Connection Point Definition	
Name	Description
Vin	Positive supply voltage.
Gnd	Supply Ground (0V).
CTRL	Internal voltage ref. pin (1.25). This pin can be used to achieve dimming and soft-start, and for switching the output current off. <ul style="list-style-type: none"> <li>• Leave floating for normal operation.</li> <li>• See 'Other Features' section to achieve dimming, and soft-start and for switching the output current off.</li> </ul>
LED A	LED A connects to the external LED anode
LED K	LED K connects to the external LED cathode

#### AP8803EV1 Basic operation at full voltage

1. Connect Vin and Gnd  
Warning: The board does not feature reverse battery/supply protection.
2. Set the PSU to 30V
3. Turn on the PSU and the LED will illuminate and the current should be approximately 680mA.  
Warning: Do not stare at the LED directly.

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**Circuit features (Remove power whilst changing components!)****Soft-start**

1. Fit a capacitor at C2 to alter the rise-time of the CTRL pin at start-up. The output impedance is 200k so  $200,000R \times C2$  (farads) is the time constant to reach 66% of the maximum output current

**Switching the output current off**

1. Shorting the CTRL pin to Gnd will cause the LED current to go to zero. Releasing this pin will create a soft-start power-up sequence.

**Changing the LED current**

1. Remove R1.
2. Calculate and fit a new sense resistor, R1, the value of which is based on the required LED current without dimming. R1 can be calculated using following equation :

$$R1 = 0.1V/I_{OUT} \quad \text{where } I_{OUT} = \text{the LED current.}$$

R1 = the sense resistor value in ohms.  
0.1V is the nominal sense voltage with 'CTRL' open circuit or set to 1.25V.

**PERFORMANCE**

The system efficiency depends on the sense resistor, supply voltage, switching inductor and the number of LEDs.

With a 30V supply, the switching frequency is typically 200kHz, and the efficiency level is >85% .

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